(12) UK Patent Application (19) GB (11) 2 161 427 A

(43) Application published 15 Jan 1986

(21) Application No 8514787

(22) Date of filing 11 Jun 1985

(30) Priority data

(31) 8415046 (32) 13 Jun 1984 (33) GB

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(51) INT CL⁴
B29C 53/06

(52) Domestic classification
B6J 201 205 802 F5 H
U1S 1786 B6J

(56) Documents cited
GB 1507786 GB 0997784
GB 1398727

(58) Field of search
B6J

(54) Forming containers

(57) A method and apparatus for forming containers *in one embodiment* includes feeding thermoplastics sheet 20 from a supply station 11 to a fold line forming station 12, and hence cooling, cutting and stacking stations 13, 14, 15. The fold forming station includes a head 16, carrying a number of heated rules 17, and an anvil 18 provided with a vacuum bed in its support surface 19; the vacuum bed being constituted by a portion of the surface 19, openings therein, a plenum and a vacuum source (not shown). The vacuum bed holds the sheet 20 against distortion except along the fold lines during the application of rule 17, but releases the sheet when the head 16 is lifted. In *another embodiment* laser 22 and associated apparatus may replace the head 16.

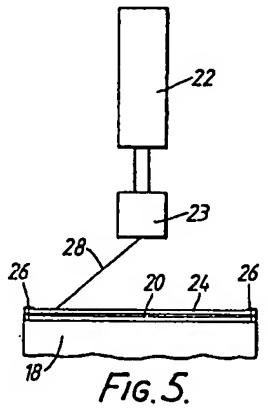

FIG. 5.

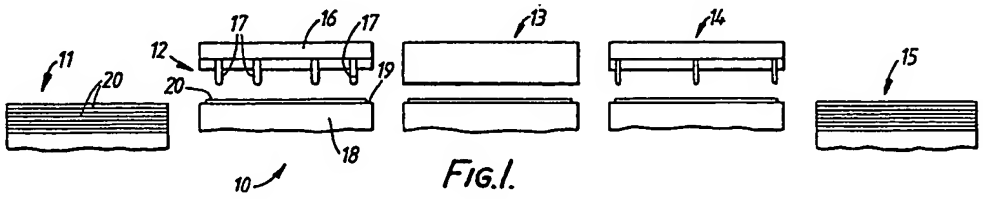

FIG. 1.

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The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

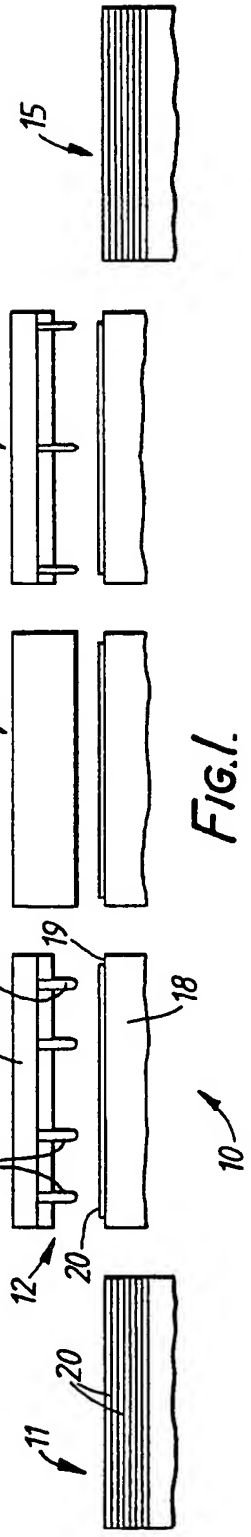


FIG.1.

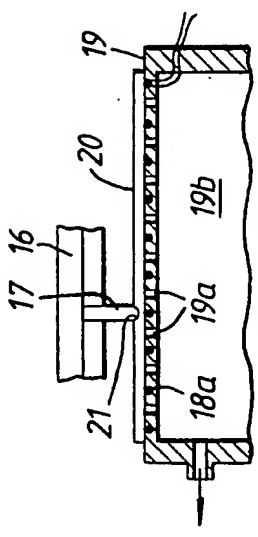


FIG.2.

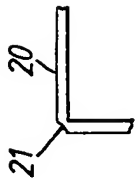


FIG.3.

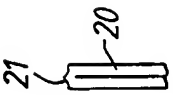


FIG.4.

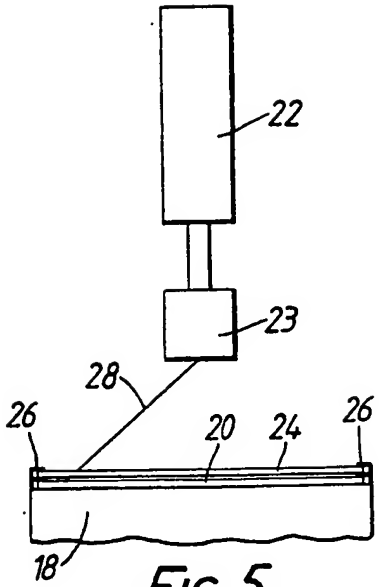


FIG. 5.

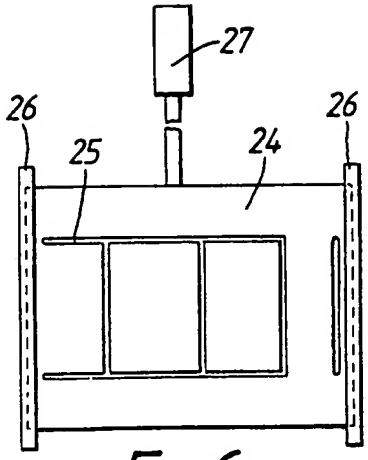
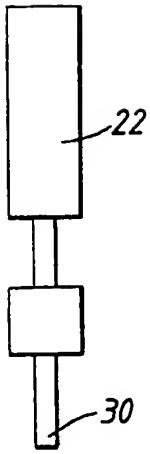


FIG. 6.



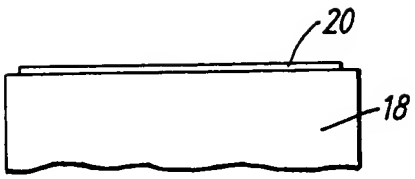


FIG. 7.

SPECIFICATION

A Method and apparatus for forming containers

This invention relates to a method and apparatus for forming containers, and in particular, but not exclusively, to containers which can be erected from a single flat sheet.

There is a considerable demand in the packaging industry for containers which are made from transparent thermoplastics material (e.g. P.V.C.) and which can be stored or transported in the flat. If such containers are to be other than circular in section this requires a large number of fold lines to be formed in the thermoplastics sheet. The ease with which the containers can be erected and the standard of their appearance depends very much on the quality of the fold lines.

Very many proposals have been made for forming such lines, but they have either required expensive equipment, for example radio frequency heating apparatus, or they have produced relatively inadequate fold lines. One of the reasons for this is that the application of heat to a thermoplastics sheet causes considerable distortion and hence only very low temperature devices tend to be used.

It is an object of this invention to provide an improved method and/or apparatus for forming containers which reduces or overcomes at least some of the above mentioned problems.

From one aspect the invention consists in a method of forming a folding container from a sheet of thermoplastics material, including forming at least one fold line by applying a heated rule to the sheet and holding the sheet against an anvil during the application of the rule to prevent distortion of the sheet other than along the line of the rule.

It will be appreciated that the term 'rule' covers any relatively narrow edge which can be used to form a fold line and is not limited to straight rules.

In a preferred form of the method the sheet is held against the anvil by a vacuum bed and conveniently the vacuum seal with the sheet is made by the pressure of the rule and hence the seal may be broken when the rule is removed. The anvil may be heated to not more than 100°C.

Preferably the rule is applied to the sheet for between 2 to 5 seconds and has its working edge heated to over 180°C, for example to between 190°C and 210°C. The rule may penetrate at least 50% into the thickness of the sheet.

From a further aspect the invention consists in a method of forming a folding container from a sheet of thermoplastics material, including applying a rule heated to over 180°C to the sheet to form a fold line and maintaining the rule in contact with the sheet for at least 2 seconds.

From another aspect the invention consists in a method of forming a folding container from a sheet of thermoplastics material, including forming at least one fold line by heating the sheet along the line, applying a rule in the heated area and holding the sheet against an anvil during the heating to prevent distortion of the sheet other than along the line.

From a still further aspect the invention consists in an apparatus for forming a folding container from a sheet of thermoplastics material, having a heated rule, an anvil including a vacuum bed for holding the sheet and means for urging the rule into contact with the sheet.

Preferably the vacuum bed is so formed or arranged that it only retains the sheet against the anvil when the rule is in contact with the sheet.

The invention also includes a container made by the method or apparatus defined above and additionally includes a container having a fold line formed by a contact heating rule, wherein the fold line is concave on one surface and rigded on its other surface.

In a preferred embodiment the fold is formed by bending the sheet along the line in a sense to open out the concavity of the fold line. In either case the thickness of the sheet may be substantially maintained through the fold line.

Although the invention has been defined above it will be appreciated that it also includes any inventive combination of the features set out above or in the following description.

The invention may be performed in various ways a specific embodiment of which will now be described with reference to the accompanying drawings, in which:-

Figure 1 shows schematically apparatus for manufacturing folding containers;

Figure 2 shows a detail of a fold line being formed;

Figure 3 shows an end view of a fold line folded through 90°

Figure 4 shows an end view of a fold line bent through 180° and;

Figures 5, 6 and *7* show laser embodiments of this invention.

A container manufacturing apparatus is shown in Figure 1 and generally indicated at 10. The apparatus 10 comprises a line constituted by a number of stations arranged in series: a sheet supply station 11, a fold line forming station 12, a cooling station 13, a cutting station 14 and a stacking station 15. An automatic feed (not shown) of a type well-known in the art is provided for moving the sheets sequentially through the apparatus.

The cooling station 13 and cutting station 14 will not be described in detail as they could be configured in many ways. The fold forming station 12 comprises a head 16, which carries a number of rules 17 which can be heated, and a rigid anvil 18 which incorporates a vacuum bed.

The vacuum bed essentially comprises the support surface 19 of the anvil 18 which is apertured to provide openings 19a to an internal plenum 19b which is connected to a source of vacuum (not shown).

The apertures 19a and the source of vacuum are arranged so that a sheet 20 lying on the anvil can be readily moved across the surface 19 when the head 16 is raised. However when the head 16 is lowered the rules 17 engage the sheet 20 and provide sufficient downward pressure to form a vac-

uum seal around the apertures and hence the sheet 20 becomes locked to the support surface 19.

By suitable design and placement of apertures in the support surface 19, the sheet can be held against any heat induced distortion other than along the lines of engagement of the rules 17 on the sheet 20. In addition the combination of a rigid anvil and the vacuum prevents displacement of material out of the plane of the sheet on the anvil side. This not only provides a fold line which is smooth or slightly concave on one side and hence aesthetically pleasing and practically important, it also provides a fold line with little spring back resilience, which is an important erection consideration.

Thus, in operation, the feed mechanism (not shown) takes a sheet 20 from the supply station 11 and delivers it on to the support surface 19 in a registered position. The head 16 is then lowered and the heated rules applied to the sheet 20. As has been explained above, the sheet 20 is then held against distortion other than along the lines of the rules 17 and hence the rules can be heated to much higher temperatures than have normally been used, for example between 190°C and 210°C, without disfiguring or distorting the final container.Further, this heat can be applied for a considerable time and a dwell time of 2 to 5 seconds is preferred.

The result of that extra heat and longer application time is that a well defined groove is formed along the line of engagement of each rule 17 as can be seen in Figure 2. Further because the sheet is firmly held the groove takes the form of a bend in the material, without unnecessary displacement of material in the plane of the sheet.This results in a groove which can be bent in a sense to open the concavity of the fold line 21 (see Figure 3), in which position the fold is naturally held open. Further it enables material to be folded through 180°C (see Figure 4).

Once the fold lines have been formed the sheet is passed to a cooling station 13 and thence to a cutting station 14, where it can be cut into the individual containers formed by the rules. From there the sheets 20 are moved to the stacking station 15. Surprisingly, although heat is applied to only a small area of the sheet, it has been found that positive cooling of fold lines considerably enhances the final product and in particular reduces fold line distortion.

It will be appreciated that other methods of holding the sheet 20 to the anvil may be used, but they should not interfere with the passage of the head 16 and must be rapidly releasable. Equally it is desirable that they provide highly localized engagement.

If a high throughput is required from the machine, the rules 17 may provide insufficient heat to the sheet 20 given the reduced cycle time. Accordingly the anvil 18 may include electrical heating means 18a for maintaining the anvil at a temperature of no more than 100:dgC and preferably above 70°C, i.e. hot enough to preheat th sheet but not hot enough to cause deformation except when additional heating by the rule takes place.

In this arrangement the cooling station 13 is even more significant, as the heated anvil would prevent effective cooling at the station 12 and hence the formation of proper fold lines.

From another aspect the invention includes apparatus for forming a fold line or other cut in a plastics sheet, comprising means for directing a laser beam on to a surface of the sheet and means for producing relative movement between the sheet and the beam to define the location and extent of the line of cut.

In a preferred embodiment means are provided for holding the sheet during the cutting operation to prevent distortion of the sheet other than along the line swept out by the laser beam. For example, there may be an anvil, in the form of a vacuum bed for holding the sheet.

The sheet or the beam may be movable to produce the relative movement.In the latter case, movement may be achieved, for example, by moving the laser producing the beam, by moving the optical system disposed in the path of the beam (e.g. a mirror) or by providing a grid array of optical fibre and switching the beam between fibre in the array.

The apparatus may include a control system for the directing means whereby the beam can be moved in accordance with a pattern or design presented to, and scanned by, the control system.

If the laser is moved it may be held on a robotic arm programmed to achieve a particular pattern of cut.

Means may be provided for altering the energy of the laser beam or the rate of relative movement to provide cuts of different depths, for example, to allow hinges to be formed, by cutting alternate segments to alternate depths.

Means may also be provided for altering the width of the beam so as to alter the width of the cut.

It will be appreciated that the anvil 18 described above is particularly suited for use with a laser; the laser replacing the head 16. For example in Figure 5 a laser 22 and an optical raster scanner 23 are used in conjunction with a mask 24, which overlies the sheet 20.Slots 25 are cut in the mask (see Figure 6) to define the area of cut. To ease feeding of the sheets 20 the mask may be slidably movable on guides 26 into and out of the work position by a ram 27. The combination of the mask 24 and raster scanning of the laser beam 28 allows for intersecting fold lines in contrast to straight laser cutting in which a double pass would occur at the intersections.

An alternative arrangement is to place the mask in a mask holder 29 and to focus the laser by focusing means 30 or to appropriate parts of the sheet 20. This arrangement is shown in Figure 7.

The operation of the vacuum bed may need to be adapted in the absence of pressure from the head 16, for example by use of valves or intermittent operation. Alternatively means may be provided for applying mechanical pressure to the sheet 20 during formation of the fold lines.

The invention includes articles made by the apparatus or the method described below, and in particular includes folding containers. In a further aspect the invention consists of a method of forming fold lines in a plastic sheet using a laser to cut the fold lines.

CLAIMS

1. A method of forming a folding container from a sheet of thermoplastics material, including forming at least one fold line by applying a heated rule to the sheet and holding the sheet against an anvil during the application of the rule to prevent distortion of the sheet other than along the line of the rule.

2. A method of forming a folding container from a sheet of thermoplastics material, including forming at least one fold line by applying a heated rule to the sheet, holding the sheet against a rigid anvil during the application of the rule to prevent distortion of the sheet other than along the line of the rule and positively cooling the sheet after the rule has been removed.

3. A method as claimed in Claim 2, wherein the sheet is held against the anvil by a vacuum.

4. A method as claimed in Claim 3, wherein the vacuum seal with the sheet is made by the pressure of the rule.

5. A method as claimed in Claim 4 or Claim 3, wherein the vacuum seal with the sheet is broken when the rule is removed.

6. A method as claimed in any one of the preceding claims wherein the anvil is heated to between 70°C and 100°C.

7. A method as claimed in any one of the preceding claims wherein the rule is applied to the sheet for between 2 to 5 seconds.

8. A method as claimed in any one of the preceding claims, wherein the edge of the rule is heated at over 180°C.

9. A method as claimed in Claim 7, wherein the temperature of the edge of the rule is between 190°C and 210°C.

10. A method as claimed in any one of the preceding claims, wherein the rule penetrates at least 50 per cent into the thickness of the sheet.

11. A method of forming a folding container from a sheet of thermoplastics material, including applying a rule heated to over 180°C to the sheet to form a fold line and maintaining the rule in contact with the sheet for at least 2 seconds.

12. A method of forming a folding container from a sheet of thermoplastics material, including forming at least one fold line by heating the sheet along the line, applying a rule in the heated area and holding the sheet against an anvil during heating to prevent distortion of the sheet other than along the line.

13. Apparatus for forming a folding container from a sheet of thermoplastics material, having a heated rule, a rigid anvil including a vacuum bed for holding a sheet, means for temporarily urging the rule into contact with the sheet and means for positively cooling the sheet after the rule has been removed.

14. Apparatus as claimed in Claim 13, including means for heating the anvil to between 70°C and 100°C.

15. Apparatus as claimed in Claim 13, wherein the vacuum bed is so formed or arranged that it retains the sheet against the anvil only when the rule is in contact with the sheet.

16. A folding container made by the method of any one of Claims 1 to 12 and/or by means of the apparatus of Claims 13 to 15.

17. Apparatus for forming a fold line or other cut in a plastics sheet, comprising means for directing a laser beam on to the surface of a sheet and means for producing relative movement between the sheet and the beam to define the location and extent of the line of cut.

18. Apparatus as claimed in Claim 17, wherein means are provided for holding the sheet during the cutting operation to prevent distortion of the sheet other than along the line swept out by the laser beam.

19. Apparatus as claimed in Claim 18, wherein sheet holding means are constituted by an anvil in the form of a vacuum bed.

20. Apparatus as claimed in any one of Claims 17 to 19, including an optical system disposed in the path of the beam for producing movement of the beam relative to the sheet.

21. Apparatus as claimed in any one of Claims 17 to 19, including means for mechanically moving the laser relative to the sheet.

22. Apparatus as claimed in any one of Claims 17 to 21, including control means for altering characteristics of the laser beam to alter the characteristics of the resultant cut.

23. Apparatus as claimed in any one of Claims 17 to 22, further including a mask for defining the lines cut by the laser.

24. A method of forming a folding container from thermoplastics sheet substantially as hereinbefore described with reference to the accompanying drawings.

25. Apparatus for forming a folding container from a sheet of thermoplastics material substantially as hereinbefore described with reference to the accompanying drawings.

Printed in the UK for HMSO, D8818935, 11/85, 7102.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.